Renewable and Sustainable Energy Reviews 30 (2014) 371–380

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

The barriers and institutional arrangements of the implementation of renewable portfolio standard: A perspective of China

Zhao Xin-gang, Feng Tian-tian, Cui Lu*, Feng Xia

School of Economics and Management, North China Electric Power University, Beijing 102206, China

ARTICLE INFO

Article history:
Received 5 June 2013
Received in revised form
2 September 2013
Accepted 21 October 2013
Available online 12 November 2013

Keywords:
China
Renewable portfolio standard
Barrier

ABSTRACT

Compared to the Feed-in tariff in China, the Renewable Portfolio Standard (RPS) could not only help to change the driving force of renewable energy industry development, but also provide the renewable energy industry with incentives to achieve the governments' planned goal. This paper first compares the features of RPS of the major industrialized countries. Second the barriers of implementing the Renewable Portfolio Standard in China are analyzed from five aspects. Finally, based on the above analysis, this paper puts forward relative institutional arrangements for the implementation of Renewable Portfolio Standard in China making recommendations for the development of renewable energy industry.

Contents

* Corresponding author. Tel.: 86 10 51963571; mob.: +86 188 1017 5254.
E-mail addresses: kj2008084008@126.com, 413991874@qq.com (C. Lu).

1364-0321/$ - see front matter
http://dx.doi.org/10.1016/j.rser.2013.10.029

1. Introduction

Nowadays, China's economy is going through a crucial period. The gap between energy demand and supply and the low energy efficiency not only make the problems of energy security and environmental protection more serious, but also influence the stability and persistence of the development of China's economy. Therefore, it is an urgent issue to ensure the steady growth of China's economy on the basis of the coordinated development of economy and environment. On December 15, 2011, the National Energy Administration announced the Twelfth Five-Year Plan (2011–2015) on Renewable energy industry development. It indicated that China would endeavor to form the renewable energy industry's scale and basic industry chain to build a competitive renewable energy industry system during the Twelfth Five-Year Plan period [1].

In comparison to traditional industries, generating electricity and consumption are the main barriers in the renewable energy power generation industry. The reasons for these barriers are the high generation cost, the lack of policy support and immature technologies. For example, the cost of photovoltaic power generation is 11–18 times the cost of thermal power electricity [2]. To eliminate the barriers, it is the high time to make innovations in institutions. Liang Zhipeng, the deputy leader of the Renewable Energy Bureau of the NEA, said that "Without the institutional reform, the wind power, solar power and others are close to saturation and cannot be developed any more". During the next five years, China will carry on the RPS and promote its construction. "We should continue to formulate and improve the design of renewable energy policy, especially the quota system and trading system" said Shi Lishan, the deputy leader of the Renewable Energy Bureau of the NEA [3].

To implement the RPS in China smoothly, this paper compares the features of RPS of the major industrialized countries and then analyzes the barriers of implementing the RPS in China from five aspects. (1) The unbalanced development of regional economy; (2) the scale barrier of renewable energy industry; (3) the delay construction of power grid; (4) the lack of market base; (5) the inadequate incentive mechanisms and supervision mechanisms. At last, this paper focuses on the institutional arrangements of the RPS in China, which would be helpful to develop the renewable energy industry scale and establish the competitive industry system.

2. Literature review

2.1. The Renewable Portfolio Standards

At present, scholars studying the Renewable Portfolio Standards mainly focus on the impact of Renewable Portfolio Standards on energy system, economic system and environmental system. The impact of renewable portfolio standards on energy system mainly includes the direct impact on the electricity market. Bird et al., using the model of ReEDS, evaluate the positive effect of RPS and cap-and-trade policy option on the U.S. electricity sector [4]. And Kildegaard also proves that the renewable portfolio standards has a positive effect on the static efficiency and dynamic efficiency for energy market [5]. Jiacai and Gong analyze the feasibility of RPS in China, and then promote the framework and the implementation steps of RPS [6]. Considering that the policy defect can be made up by the reasonable institutions, Xingang and Jieyu, and Pingping put forward a rational institutional design [7,8].

The researches on the impact on economic system and environmental system mainly analyze the economic and environmental benefits. Palmer et al. evaluate the economic and environmental benefits of three policies, including the cap-and-trade program (CTP) on emissions, the RPS and the tax credits for renewable energy producers [9]. Contaldi et al. use the MARKAL model to evaluate the overall effect of the RPS in Italy [10]. And Finon and Perez compare feed-in tariff and the Renewable Portfolio Standards in the aspects of controlling the consumer cost, guaranteeing green electricity investment, increasing the market incentives and ensuring the long-term adaptability of policies [11]. Chandler discusses the RPS as an endogenous variable in social system and concludes the positive effect of the RPS on technology and innovation [12].

2.2. Tradable green certificates

TGC, as a supporting policy in RPS, has been researched in many literatures. Because of the difference between research method and angle, the viewpoints of scholars may be different and controversy.

At present, some scholars highlight that TGCs brings positive effect to renewable energy industry, power industries, and other systems in some respects. Mátyás Tamás, using the data from the UK market, finds that social welfare under TGC is consistently higher than FIT for a wide range of values of the parameters [13]. Knutsson et al., Ungeret al. and Amundsen and Mortensen, taking Sweden and Nordic as examples, analyze the positive effect on the electricity spot market after introducing the TGC system [14–16]. Morthorst introduces the international TGCs to an open power market and analyzes the cost effectiveness and the contribution on greenhouse gas reduction [17]. Jensen and Skytte suggest that carbon emissions trading and TGCs are effective in achieving the goals of emission reductions and renewable energy [18].

On the contrary, many scholars hold the view that many problems and market risks may be brought with the implementation of TGCs. There are also some scholars question whether TGCs is cost effective in some aspects.

Tsao et al. find that there would be policy redundancy in a situation at which two policies – the renewable portfolio standards (RPS) and the emissions trading (C&T) – co-exist in a competitive electricity market [19]. Fristrup thinks the obstructive elements of implementing TGCs include the establishment of incentive mechanisms, diversified renewable energy power generation technology and excess capacity [20]. And Nielsena and Jeppesen, Verhaegen et al. indicate that it was difficult to build a unified TGC market because of the different types of TGC in Europe [21,22]. As for the market risk of TGCs, Lemming analyzes financial risks in the TGC market from existing renewable producers and potential investors. He proposes that the regulators should

attempt to make the market as transparent as possible to minimize this negative effect posed by fluctuations in production and incomplete information about supply and demand [23]. Ford et al. calculate and simulate the dynamic price of TGC using the data from Europe and America [24]. Amundsen et al. show that introduction of banking of GCs may reduce price volatility considerably and, furthermore, as expected lead to increased social surplus [25]. Agnolucci shows that the financial constraint and long-term contracts can guarantee the operation of TGC market [26].

With regard to the cost effectiveness of TGCs, Cliff Chen et al. (2008) calculate the cost effectiveness of TGCs with 31 states in the U.S [27]. And Nilsson and Sundqvist study the cost of TGC in Sweden and find that the implementation of TGCs improves the cost of electricity retail market [28]. Bergeka and Jacobssonb, assessing the performance of the Swedish TGC system, find that consumer costs and rents under TGC have been substantially higher than expected. And it contributes marginally to technical change [29]. Marchenko shows that a mechanism of green certificates is not an ideal means for minimizing the impact of energy on the environment: the economic effect turns out to be smaller than the maximum possible one [30]. Aune et al. conclude that the trading of green certificates can ensure a cost-effective distribution of renewable energy production, but the national targets prevent a cost-effective distribution of energy consumption [31].

As can be seen from the literature review, a lot of work has been done towards the Renewable Portfolio Standards, which mainly concentrate on the impact of Renewable Portfolio Standards on energy system, economic system, environmental system, TGCs and so on. Nevertheless, fewer scholars made in-depth study of the barriers and institutional arrangements of the implementation of Renewable Portfolio Standard in China. During the "Twelfth-Five Years Plan", China would carry on the Renewable Portfolio Standard (RPS). In order to ensure the implementation of RPS in China, this paper will, based on previous studies and the experience of foreign countries, focus on studying the specific barriers and institutional arrangements of the implementation of Renewable Portfolio Standard in China.

3. The China's current situation and the foreign experience of the implementation of RPS

3.1. The current situation of the renewable energy in China

On December 15, 2011, the National Energy Administration announced the Twelfth Five-Year Plan (2011–2015) on Renewable energy industry development. It indicated that China would endeavor to form the renewable energy industry's scale and basic industry chain to build a competitive renewable energy industry system during the Twelfth Five-Year Plan period. From Table 1, you can see the forecasting of the installment capacity in China. By 2015, the development amount of the non-fossil fuels including wind energy, biomass energy, solar energy and many others would reach 480 million tons of standard coal, and the share of non-fossil fuels in primary energy consumption would be increased from the current 7.8% to 11.4%. Meanwhile, China will launch the renewable Portfolio Standards (RPS) to promote the construction of RPS transaction system [1].

China now has not established the TGC trading market yet, which is disadvantageous to its economy development. With the promulgation of China's the renewable energy law in February 2005, China will not rely on traditional energy mainly, and mainly depend on renewable energy beyond 2020.

3.2. Important issues of the RPS

The Renewable Portfolio Standard (RPS) is a new policy instrument to support the development of renewable energy for China. There are so many factors should be taken into consideration in the process of designing such a support scheme for renewable electricity. They mainly contain the following issues [32].

- Setting the right amount.
  A prior condition of the Renewable Portfolio Standard is to legislatively set the minimum percentage and to define the increase of the obligation over time as well as the final target. In order to make the system working, the quota needs to be widely accepted. Therefore, the explicit target of renewable energy power generation should be set by a high-ranking authority, i.e. by law. In addition, governments should define a long-term target in consideration of continuity and certainty for the expectations of investors, which can be divided into smaller short-term targets.
- Eligible technologies.
  On the basis of the situation in each country, governments should determine which renewable energy technologies are eligible in the market. Technologies that are close to being market ready may be suitable.
- Actors under obligation.
  Of course, who would be the entities under obligation is also very important. The entities mainly include the final consumer, the retail supplier, the generators, the grid companies, or the distribution companies. According to the organization of the electricity system in each country, there are different situations.
- Design of TGC.
  It is very important to design the green certificates carefully. Each TGC represents a certain amount of electricity generated

Table 1
The forecasting of the installment capacity in China (10 MW).
Source: State Grid's annual report of energy and power in 2012.

Items	2009		2012		2015		2020[年]	
	Capacity	Proportion (%)	Capacity	Proportion (%)	Capacity	Proportion (%)	Capacity	Proportion (%)
Total installed capacity	87,406		11,5273		134,706		175,614	
Conventional hydropower	18,254	20.88	24,945	21.64	28,773	21.36	34,801	19.8
Pumped storage	1,424	1.63	2,282	1.98	2,823	2.00	5,319	3.0
Coal	62,438	71.43	77,719	67.42	87,580	65.60	103,396	58.9
Gas	2,568	2.94	3,307	2.87	3,567	2.60	5,168	2.9
Nuclear	908	1.04	2,262	1.96	4,284	3.10	8,030	4.6
Wind	1,613	1.85	4,176	3.62	6,309	4.50	15,000	8.5
Biomass	185	0.21	488	0.42	870	0.60	1,500	0.9
Solar	16	0.02	94	0.08	500	0.40	2,400	1.4

[年] gives contrast in different years.

by renewable energy sources (the amount may vary from country to country). Certificates may reflect some information, such as a unique number, the production date, the type of renewable energy source. Generators falling to fulfill the quota can choose to purchase green certificate to meet quotas in the TGC market. Therefore, TGC is a new kind of energy commodity in the trading market.

- The penalty.
  The penalty mechanism is a clearly necessary part in the RPS to achieve targets. If there is no penalty for failing to meet the quota, the TGCs would not work. The amount of the penalty should be higher than to comply with the requirements for the responsibility principal. In the end, the penalty could be used to set up a fund to support the renewable energy.
- Market organization.
  The price of the TGC is affected by a variety of factors. The swing in price brings large risks to market participants, therefore timely, accurate and comprehensive information is very important for enterprises to reduce risk and improve profits. An authoritative trading platform is very necessary for TGC trading. Also trade can be bilateral (over the counter).
- Institutions involved.
  Depending on the institutional design of a countries' electricity sector, authoritative administrative institutions should be established or authorized to fulfill the issues mentioned above. The main task of institutions is to organize, manage and supervise the whole market.

3.3. The implementation experience from the major industrialized countries

The RPS has been affirmed by laws or regulations in major states of America, Australia, Austria, Belgium, Italy, Japan and Britain, which is of great reference value to the development of the RPS in China. In the following, we will introduce some examples (see Table 2).

As Table 2 shows, we would introduce America, England and Japan from six aspects. Talking about the renewable energy target in 2020, 20% is required to reach in America and Japan. The twice of that in 2010 is asked to meet in England. Who would be the entities under obligation is also very important. According to the organization of the electricity system in each country, there are different situations. The power retailers are the responsibility principal in America and England. However, the Japanese responsibility principal is the electric power company. Of course, these countries have issued many policies to support the implementation of the RPS. As for supervision, America, England and Japan all choose the relatively independent regulators. In addition, we can learn that these countries all set a severe punishment mechanism. The market environment of America is relatively open, competitive and orderly. And the Japanese market environment is also Fairness and evenness.

The RPS has not been implemented in these countries long enough, while the achievements are great. By summarizing the features and the development of the RPS, what we can get is as follows: (1) The renewable energy target should be appropriate to the status of economy; (2) the responsibility must be fit for the structure of power market; (3) related laws and regulations are required in the process of implementing RPS smoothly; (4) the market environment should be competitive in a certain extent.

4. The barriers of the implementation of Renewable Portfolio Standard

In the process of implementing RPS in China, there exist some crucial barriers which can be analyzed in five aspects: the unbalanced development of regional economy, the scale barrier of industry development, the lagged construction of power grid, the lack of market base and the inadequate incentive mechanisms and supervision mechanisms.

4.1. The unbalanced development of regional economy

Since the reform and opening-up, China's domestic economy increased rapidly as well as the economic status in the world. However, due to the excessive emphasis on the economic benefits, a number of regional development issues have become urgent (for example, the unbalanced development).

Fig. 1 shows the average GDP of three main economic circles and the middle-west regions. As can be seen from the figure, the GDP of the Pan-pearl River Delta Economic Zone is as high as 5.321×10^{-6} million RMB. And the GDP of the economic circle around Bohai Sea and the Yangtze River are more than 2×10^{-6} million RMB. They are much higher than that in the middle-west regions. So we can conclude that the development of regional economy is extremely unbalanced. The coastal region is flourishing, while others are less developed.

Similar with the development of regional economy, the distribution of renewable resources is unbalanced either (see

Table 2
The features of RPS in major industrialized countries.
Source: authors.

	America	England	Japan
The renewable energy target in 2020 (the percentage of total power)	20%	The twice of that in 2010	20%
The responsibility principal	The power retailers	The power retailers	The electric power company
The law	Energy Policy Act of 2005 Obama's “New Energy Policy” American Clean Energy and Security Act (ACESA)	Non-Fuel Obligation (NFO) Renewable Obligation Order Energy White Paper	New Sun Plan” National Energy Strategy Law of Special measures to promote the use of new energy Renewable portfolio standard law “Japan version of the Green new deal” plan of four
The independent supervision	State Public Utility Commission“	OFGEM	Advisory Committee for Natural Resources and Energy
The punishment	0.05 dollars, or twice the annual average price of certificates divided by 1000 (taking the Texas as an example)	Up to the turnover of 10%	The maximum penalty for is 1million JPY
The market environment	Open, competitive and orderly	Fairness and evenness	Na

Table 3). Specifically, occupying more than 2/3 of the Chinese territory, the northwestern area is rather abundant in solar energy. Each year, the solar energy can reach 1.7×10^{-6} million tons coal equivalent. The wind power mainly distributes in the southeast and offshore area which are about 282 million tons coal equivalent. Furthermore, the biomass energy is rich but the distribution is uneven. The agricultural biomass energy is mainly in the northeast China and Tibet, while the forestry biomass energy is mainly in southwest China. The total amount of biomass resources in China is about 650 million tons coal equivalent. As for the hydro power, the amount is about 140 million tons coal equivalent near the Yangtze River and the Yellow River. The explored geothermal energy is about 3300 million tons coal equivalent and the majority is in the south Tibet, Yunnan and the west Sichuan.

As seen in Fig. 1 and Table 3, the energy consumers are mainly in the coastal region, while the energy resources are mostly in the central and western China. It make the unbalanced development of regional economy more serious.

4.2. The scale barrier of renewable industry

With the rapid development of China's economy, the demand for energy also has a great improvement. With the rapid development of renewable energy industry, China has the largest exploiting scale of renewable energy including the hydro power. The installed capacity of renewable energy in China accounts for 23% of the total. However, as can be seen from Fig. 2, the feed-in tariff is too low to make up the high generation cost of renewable industry. It makes renewable industry loss or little profit which affects the manufacturers' enthusiasm to develop renewable energy and further leads to the scale barrier of renewable industry. In another aspect, the technology determines the development of renewable industry as well. The uneven distribution and immature technology lead to the scale barrier of renewable industry.

In Table 4, excluding the hydraulic power generation, the commercial extent of solar energy, wind power and others is at the primary period. As we can see, the majority of these renewable industries can operate mainly by the subsidies from the government. Compared with those in industrialized countries, the whole renewable industries in China are at the primary period except the hydraulic power generation.

4.3. The lagged construction of power grid

In recent years, China's renewable energy developed fast and the investment scale increased rapidly, especially in the wind power electricity and solar energy electricity. In 2002, the installed capacity of the wind power was just 0.47 MW. In 2011, the new installed capacity of wind power was 17630.9 MW, increasing by 39.4% compared with that in 2010. The new installed capacity of solar energy was about 2.2 MW, accounting for 7% of the world in 2011. The renewable power develops fast, but the construction of power grid lags behind. Because the distance between renewable energy area and center of the power load is long, a majority of the renewable electricity can not be consumed on-the-spot which should be transmitted through the power grid. As a result, in 2011, only 16,000 MW wind power has been on grid which is much less than the number of new installed capacity [33]. As for the solar energy, the installed capacity increased sharply, while the generation cost is high. And the resource-rich land was remote with the poor grid construction.

In the early period, the renewable industry developed without planning and guiding, which led to the production capacity surplus. Due to the lagged construction of power grid, the surplus electricity could not be on grid, resulting in a waste of resource. On the other hand, the lagged construction of power grid also makes it difficult to interregional trade and transmission, which is not conducive to the implementation of RPS. So the lagged construction of power grid is a barrier of implementation of RPS. A way to solve it is that China should invest more in the power grid to widen the transmission capacity of power grid.

4.4. The lack of market base

In order to ensure the trade of the TGC, it is necessity to establish a stable market which cannot be disturbed by improper actions. The

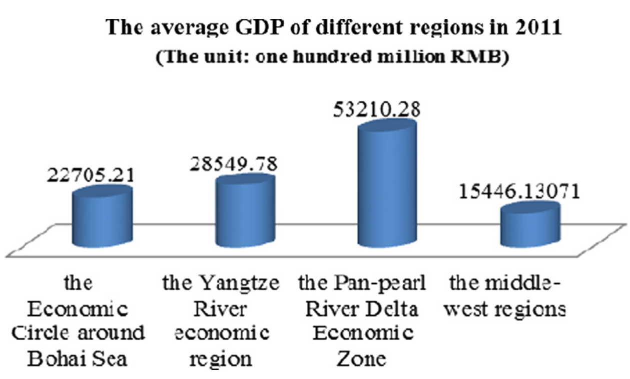


Fig. 1. The average GDP of different regions in 2011.
Source: http://www.cei.gov.cn/.

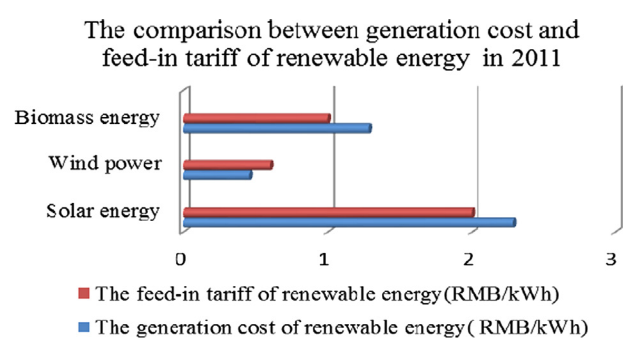


Fig. 2. The comparison between the generation cost and feed-in tariff of renewable energy in 2011.
Source: http://www.eri.org.cn/index.php.

Table 3
The capacity and main distribution of renewable energy.
Source: National Energy Administration.

	The amount of renewable energy per year (million tons coal equivalent)	Main distribution areas
Solar energy	1.7×10^{-6}	The northwest China
Wind power	282	The Southeastern coast, nearby islands and northern regions
Biomass energy	650	The northeast and southwest of China and the Tibet Autonomous Region
Hydro energy	140	The Yangtze River and the Yellow River
Geothermal energy	3300	The south Tibet, Yunnan and the west Sichuan

Table 4
The commercial extent of renewable energy.
Source: authors.

	The commercial extent
Solar energy	The heat using is relatively mature, while the cost of photovoltaic power generation is high
Wind power generation	The scale is growing but the equipment cost is high. It barely maintains breakeven relying on the subsidy
Hydraulic power generation	The degree of industrialization is high and mature. The earning is stable with a higher gross profit
Biomass fuel	Most are in the development stage
Ethanol	In the popularized period and relying on the subsidy
Geothermal energy	Majority has been developed and relying on the subsidy

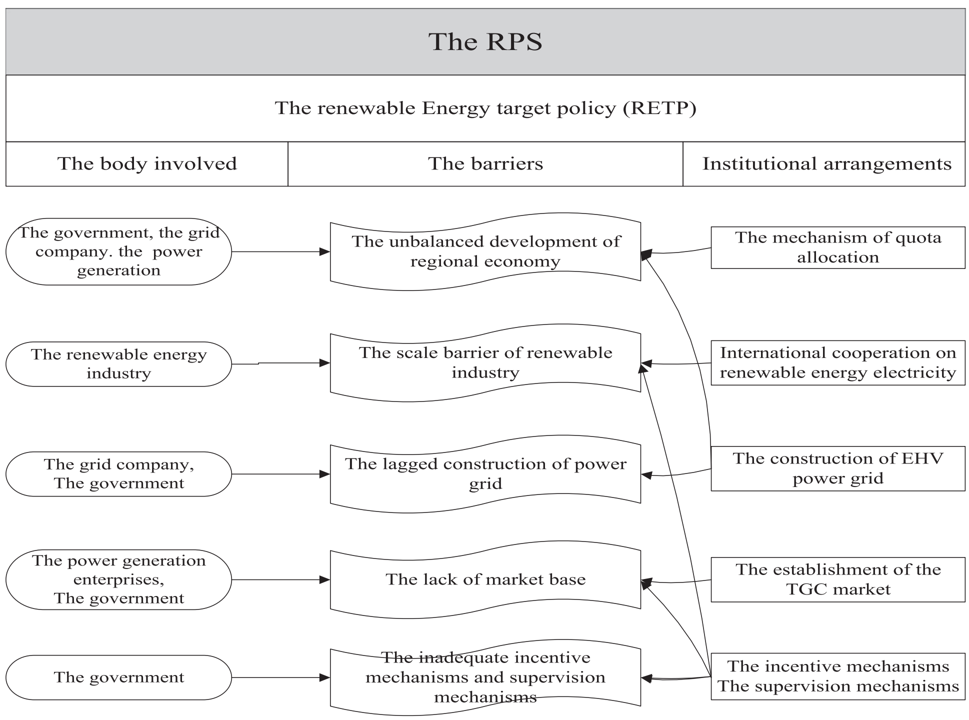


Fig. 3. The framework of institutional arrangements.

newness and specific characteristics of renewable energy technologies have not lived up to the expectations of investors. The change of preference of investors to return and risk can affect the investment in renewable energy. Therefore, the access to finance in renewable energy industries is an urgent problem which would influence the market-based TGC development.

Since the price of the TGC is affected by a variety of factors, the swing in price brings large risks to market participants. Therefore, timely, accurate, comprehensive and stable market is very important for enterprises to reduce risk and improve profits. Trade can be bilateral (over the counter), which might be the case at the beginning, when the amount is small. If the trade volume is large enough, the certificates could also be traded through stock exchanges leading to more transparency and competition. In addition, price hedging instruments could be used (e.g. futures or the like) in order to reduce price risks [34].

4.5. The inadequate incentive mechanisms and supervision mechanisms

There is a lack of thorough policy system in the renewable energy industry to encourage and stabilize the investors' confidence in China, particularly the incentive mechanisms and the independent supervision mechanisms. The lack of the relevant incentive mechanism in the renewable energy industry would influence the industry scale, the motivation of market participants and the formation of the market. Further, supervision mechanism will control unfair competition, high risk or other improper actions in the market. Hence, the incentive mechanisms and the independent supervision mechanisms are very important support mechanisms in the process of implementing the RPS successfully.

5. The institutional arrangements of RPS for China

The institutional arrangements of RPS are related with the renewable energy target, the principal responsibility, the quota allocation, the law etc. According to the characteristics of China power market, the relevant institutions should be arranged to solve the problems of unbalanced development of regional economy, scale barrier and the lagged construction of power grid. Fig. 3 shows the different institutional arrangements of RPS to solve various barriers in the process of implementing the RPS.

5.1. The renewable energy target policy (RETP)

In the main industrialized countries, the renewable energy target policy (RETP) is the core and key to RPS. As is shown in Table 5, the renewable energy target in 2020 is that the non-fossil energy accounts for 15% of primary energy consumption, especially the hydro power accounts for 9%, the proportion of solar energy, biomass energy, wind power and nuclear energy are 0.8%, 1.2%, 2% and 2%, respectively.

5.2. The mechanism of quota allocation

The RPS means market-oriented. The goal is to finish the quota in a wide area, which is helpful for China to solve the unbalanced distribution both in resources and economy. As a result, determining the area and quantity of renewable energy quota scientifically can ease the unbalanced development of regional economy and affirm the equilibrium and fairness.

5.2.1. The quota allocation

According to the renewable resource, the GDP, the total electricity consumption and the transmission capacity of different provinces, China can be divided into four renewable energy power regions. From Table 6, Area I is the place with the majority of non-hydro renewable energy. Area II is the place with rich non-hydro renewable energy. Area III, which has the basic condition of receiving the other regions' electricity with less non-hydro renewable energy, can undertake the duty of consuming the renewable energy. Zhe Jiang etc. are Area IV with less renewable energy and small scale of power grid.

Area II and Area III include Bei Jing, Tian Jin and Guang Dong, where the economic level is higher than other areas. So the electricity consumption accounts for majority of the total and the renewable energy consumption trans-provincial is in the input state. Area I, including the old industrial area in northeast China, has the biggest production of renewable electricity. In Area IV, the hydro power is rich, but the non-hydro renewable energy is poor. So the renewable electricity consumption is small.

Table 5
The renewable energy target in 2020.
Source: The speech of President Hu Jintao at the UN climate change summit.

The non-fossil energy accounts for 15% of primary energy consumption, about 600 million tons coal equivalent		
	The quantity	The percentage
Hydro power	–	9
Solar energy	20 GW	0.8
Biomass energy	30 GW	1.2
Wind power	150 GW	2
Nuclear energy	–	2

5.2.2. Actors under obligation

To guarantee the successful implement of RPS, it is very important to determine who would be the entities under obligation. According to "Administrative Measures on Renewable Electricity Quotas (discussion draft) 2012", the grid company would be the main responsibility body. At the same time, large power investment enterprises and the provincial governments would also be the obligation body and administrative responsibility body respectively, cooperating with power grid companies to carry out the complete the quota scheme.

5.2.3. The quota of each principal agent

By the year 2015, the total consumption of electricity in China will be 6335 billion kW. As shown in Tables 7 and 8, the installed capacity of renewable energy of the generation company in large scale accounts for 70% and the total generation is 75%.

5.3. International cooperation on renewable energy electricity

There are abundant renewable resources, huge potential of renewable energy development and market demand in China. However, due to the lack of technology, funds and management experience in the renewable energy industries, it faces a lot of current obstacles for China to develop renewable energy. For example, the low energy efficiency, the small industrial scale and incomplete policy system still exist in China. Now it is time to make use of the favorable international and domestic environment effectively to carry out international cooperation on renewable energy power generation in a deeper level [35].

China and the advanced countries can cooperate in capital, technology or other aspects of renewable energy electricity. Countries can create a win-win situation by joint development of related technologies, energy trade, energy finance and information sharing. It is beneficial to execute the projects of building power plants, manufacturing equipments and installing the transmission lines. Thereupon, when international cooperation relieves the capital pressure, promotes the energy cooperation and drives the economic development, it also guarantees energy supply and realizes the mutual benefits.

5.4. The construction of EHV power grid

As China quickens the pace of energy exploitation towards west and north, the distance between energy resources distributions and energy demands gets longer and longer. In addition that the 750/330/110 kV ac power grids are building in the northwest, the

Table 6
The renewable quota allocation (The unit is billion kWh).
Source: The administrative measures of renewable energy electricity quota in 2012 (discussion paper).

Geographic classification	Area I	Area II	Area III	Area IV
Provinces	Inner Mongolia, Xin Jiang, Gan Su, Shan Xi, Ning Xia, Liao Ning, Ji Lin, Hei Longjiang	Bei Jing, Tian Jin, He Bei, Shan Xi, Shan Dong, Qing Hai, Yun Nan	Jiang Su, Hu Nan, Gui Zhou, Shang Hai, Fu Jian, Guang Dong, He Nan, Si Chuan, An Hui, Jiang Xi	Zhe Jiang, Hu Bei, Guang Xi, Chong Qing, Hai Nan
The total society electricity consumption in 2015	1113	1731.6	2609.9	877
The actual renewable energy power consumption	123.8	103.9	86.5	8.8
The renewable energy generation	149.7	80.1	74.35	13.45
The state of renewable energy consumption trans-provincial ("+" is input and "−" is output)	+25.9	−23.8	−12.3	+4.6

Table 7
The quota of the generation company in large scale in 2015.
Source: The administrative measures of renewable energy electricity quota in 2012 (discussion paper).

	The total installed capacity	The total generation
The total power consumption 6335 billion kW h		
The renewable power proportion of its own total generation (%)	11	6.5
The production of renewable energy power	0.862 billion kW	3547.6 billion kW h
The renewable power proportion of the total generation in society (%)	70	75

Table 8
The quota of the power grid company in 2015 (The unit is billion kW h).
Source: The administrative measures of renewable energy electricity quota in 2012 (discussion paper).

	State Grid Corporation of China	China Southern Power Grid	Inner Mongolia Electric Power Company	Shaanxi regional electric power group
The total power consumption6335 billion kWh				
The total power consumption	5195.9	1024.2	168.3	46.7
The supportability acquisition of renewable energy	248.5	32.7	25.2	4.7
The proportion of supportability acquisition of renewable energy (%)	5	3.2	15	10

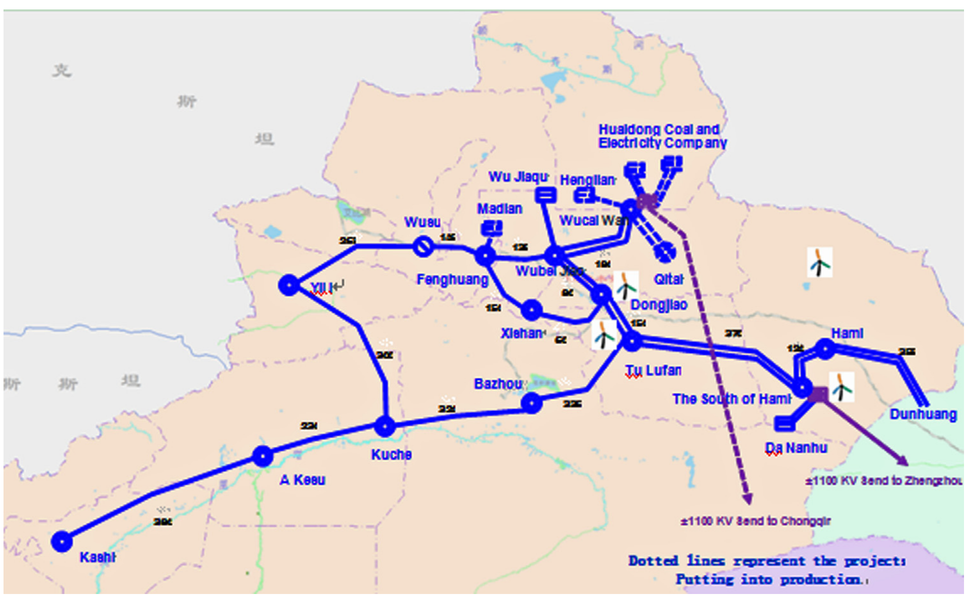


Fig. 4. 750 kV EHV Xinjiang power grid diagram in 2014.
Source: State Grid's annual report of energy and power in 2012.

550/220/110 kV ac/dc power grids is mainly power grid construction in China. Consequently, electricity transmission capacity and scale are severely constrained and cannot meet the future requirements of large-scale and long-distance transmission, which is also the barrier of the implementation of Renewable Portfolio Standard.

In order to support mass, long distance, high efficiency transmission of electrical energy in the future, it is necessary for China to speed up the development of EHV transmission technology, achieving optimal configuration of national energy. The construction of the EHV provides convenience for cross-regional trade under RPS. It is necessary to develop the technology of EHV for upgrading technology of power grid, promoting comprehensive competition and technological innovation in scientific research, design, manufacture and construction.

750 kV EHV (extra high voltage) Xiniang power grid diagram in 2014 is shown in Fig. 4. The construction of the 750 kV EHV in Xinjiang contributes to optimize the structure of China's energy supply, guarantees the balanced development of regional economy and promotes the sustainable development of national economy. On the other hand, the construction of EHV is of great realistic significance for meeting the needs for economic and social development of Xinjiang and promoting the readjustment of the industrial structure in Xinjiang. The demonstration project of the 750 kV EHV of Northwest Grid is the highest voltage levels of the existing power transmission and transformation projects, is also the highest voltage level in 13 countries around the world which have the demonstration projects of this voltage level. It is the start project of transmission network of power in west to east in China.

A 500 kV power grid in northeast, central, eastern, northern and southern China, as the backbone network, is the initial stage of the power grid pattern of China in the future. With the development of the power grid, the interconnection of regional power grids can be realized. Finally the national power grid would be formed. The voltage level in China would develop from the 220 kV to Extra High Voltage.

5.5. The establishment of the TGC market

In consideration of the inequality of regional economy in china, the government should set up several regional trading markets in the developed areas first. Then a large national market can be formed gradually on the basis of TGC markets in the developed areas. Funds and technologies in the eastern coastal areas would be utilized to develop the rich renewable energy resources in the central and western regions. Seeing the domestic market, the development of Chinese renewable energy will be very fast in the coming decades, that is to say the TGC market has the great potential in the future. A unified TGC trading market not only helps government with centralized management but also expands the scope of transaction. From the international market, a national TGC market can save transaction costs, so it would attract more buyers and sellers definitely. This is beneficial to the prosperity of Chinese TGC market, and the building of an international TGC trading platform. Therefore, the establishment of a national TGC trading platform is very necessary from the strategic point of view.

5.6. The incentive mechanisms and supervision mechanisms

To guarantee that the RPS can be successfully implemented, the government should help the renewable energy industry achieve the scale. It's necessary to establish the relevant incentive mechanisms solve the problem of the industry scale barriers. On one hand, a direct action should be given to the renewable energy industry, such as price subsidies, tax preferences and so on. The circular of the National Development and Reform Commission on improving the policies for on-grid wind power prices, which was published in 2009, claims the wind power bench electricity price level in four kinds of resource areas: 0.51 RMB/kW h, 0.54 RMB/kW h, 0.58 RMB/kW h and 0.6 RMB/kW h [36]. In June of 2006, National Development and Reform Commission allowed two grid-connected in photovoltaic power generation projects to enjoy the favorable electricity price of 4 RMB/kW h [37]. Since 2008, the electricity price subsidies in biomass power generation industry have got a new 0.1 RMB/kW h rise which is from 0.25 RMB/kW h to 0.35 RMB/kW h [38]. On the other hand, the government should not only launch supportability acquisition system of renewable energy, but also help to increase the investment in power grid construction. Li Keqiang said that we should simplify administration and transfer power to stimulate the creativity of market and enhance the initiative of economic development on the conference about transformation of government functions. Devolution of authority may contribute to survival of the fittest and prevent overcapacity. The first projects mainly concentrated in the field of electric power. Nowadays, China should be engaged in constructing the smart grid which has the characteristics of informatization, digitization, automation and interaction. At the same time, the capital of the renewable energy industry development can be partly solved by establishing renewable energy development fund. Meanwhile, the government and relevant departments should encourage enterprises to set up the technical innovation system with universities, colleges and scientific research unit.

For China, the supervision of quota obligations should be undertaken by an independent department. According to the national renewable energy development and utilization planning, the Energy Administration Department of the State Council, the State Electricity Regulatory Commission and the Finance Department under the state council can determine the renewable electricity proportion of the whole electricity generation. The central government can build an independent RPS regulator. Then the independent RPS regulator can establish separately executive committees in four kinds of quota areas to supervise quota responsibility to perform quota obligation. At the same time, it should feedback the information timely to regulators. The duty of regulators mainly may include five aspects: (1) the completion of quota; (2) the price of TGC; (3) the non-production behaviors during the production process such as rent-seeking; (4) the accurate information disclosure of the production cost; (5) the punishment for agent who unfinished the quota according to the legal.

6. Conclusion

In general, we have the following conclusions:

1. At present, generating electricity and consumption are the main barriers in the renewable energy industry compared to traditional industries. To eliminate the barriers, it is the high time to make innovations in institutions. And the main advantage of renewable portfolio standard is creating competition among the power plants through market forces, which would be helpful to develop the renewable energy industry scale and establish the competitive industry system. According to China's characteristics and the development of renewable energy, there still exist some difficulties and obstacles, such as the unbalanced development of regional economy, the scale barrier of renewable industry, the lack of market base and so on. Nielsena and Jeppesen, Verhaegen et al. has also discussed the similar obstacles in the Europe green electricity market [21,22]. Fristrup also emphasized the importance of incentive mechanism in the process of implementing the RPS and TGC [20]. In spite of existing obstacles, the Chinese government is removing these barriers gradually and formulating the corresponding policies to ensure the implementation of RPS actively.
2. However, we need to realize that there is no such policy as the absolutely right policy to solve these problems of renewable energy. The renewable portfolio standard is no exception. Different policies should be applied at the same time. Introduction of different policies to support the implementation of RPS has been suggested in Espey to enhance the use of RE [34]. In other words, Chinese government should formulate an integrated policy system from the aspects of a mandatory base and a voluntary base to achieve the goals of the 12th five-year plan and the successful implementation of RPS. The RPS and some indirect subsidy schemes are indispensable parts. The Chinese government should also adjust the policies of renewable energy industry continually to make them really suit China. The renewable energy industry of China would be change gradually from policy-oriented to market-oriented in the future.

We suggest that:

1. The Chinese government ought to popularize the knowledge and benefits of renewable energy to develop public awareness and participation in the development of the renewable energy industry. At the same time, the government, the generation enterprises should cooperate with schools and scientific research institutions and pay attention to technical innovation and the cultivation of professionals, which inject fresh blood to the development of renewable energy.
2. The successful implementation of RPS cannot do without a well market base. The TGC mechanism can make the renewable energy industry operate with the visible hand and invisible hand at the same time. The positive impact of TGC on the renewable energy industry has been discussed by Morthorst [17]. The Chinese government can set up several regional trading markets in the developed areas first. And a large

national market can be formed gradually on the basis of TGC markets in the developed areas.

Acknowledgements

This paper is supported by National Natural Science Foundation of China (Granted No. 71273088) and Humanities and Social Foundation by the Ministry of Education of China (Granted No. 11YJA790218).

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